WHAT EVER HAPPENED TO TEAMWORK?
A CONCEPT OF FUTURE CUSTOMER ACCEPTANCE TESTING

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ABSTRACT

A major goal of systems procurements has been getting a quality product as quickly as possible. In the simulator world, a serious drive is now on for concurrency. Attempts have always been and will still be made to reduce the total cost of the procurement. One costly phase of the development schedule, because of its associated time and manpower requirements, is the test phase. Of particular importance is Customer Acceptance Testing. By making some significant changes to the test philosophy and how the tests are actually conducted, significant gains could be made by the contractor, buyer and user.

This paper will review doctrines of system test planning which have been held sacred by both sides. A background to the purpose and goals of system test will be presented. Additionally, the structuring of a system's various test phases will be reviewed. New ideas will then be presented on how, with cooperation and trust by all parties concerned, everyone can accomplish what they always have and now a lot more. Evidence of how implementation of some of these new ideas has worked will be reviewed.

INTRODUCTION

There are three major phases to the development of flight simulators, as well as any other product (Fig. 1). These are the Planning and Design, Hardware and Software Integration (HSI) and System Test phases. The contracted effort is defined in the customer's Prime Item Development Specification (PIDS or spec) and the Statement of Work (SOW). In the first step of the planning phase, the PIDS and SOW are broken down by the contractor into the system's major components or units. The preliminary design evolves as the unit specifications are then written, defining what that unit should do and how it interfaces with the other units of the system. As more and more is written and investigated, the design evolves further until all the details are known. Once the customer approves this final design, hardware fabrication, software coding and their integration can begin.

Initially, the various pieces of hardware and software are independantly brought together, first forming the integrated hardware and software parts of the units. Hardware and Software Integration (HSI) takes place as the hardware and software components are integrated to form the units, and then the units are integrated to form the system. In the later days of HSI, the contractor transitions to what is one of the most important phases, especially to the customer, Testing. Here all the work to date is checked. First by the contractor's engineers, then by their Quality Control department and then by the 900 pound gorilla until the contractor is sure the system will work to his best interpretation of the customer's spec without breaking. Finally, the customer has his chance to come in, and in some cases for the first time, see the system actually work and test it against the spec. Once this often arduous task is completed and all parties are satisified, the system is finally accepted for delivery to the system's next destination or final resting place.

The ultimate goal of all this work for the customer is a quality product that does what it originally was intended to do, if not more. For the contractor, it is to deliver a quality, spec-compliant product on time and at or below the target price. To enhance the ability to have a quality, spec-compliant system, extensive effort is put into the test phase by all parties. Sometimes, this phase becomes very costly. It is the time when everyone becomes very defensive of their agency's positions. Naturally, this leads to very strained working relationships between and within all parties. The effectiveness and purpose of test can often be lost in the politics involved.

Today, getting the simulator as close to the time of aircraft delivery is of ever growing importance in the flight simulation. Concurrency is becoming a major common goal. Having this concurrency obviously facilitates pilot training and the wing's preparedness. Due to all the problems which have evolved over the past years and the strong drive towards concurrency, a plan is definitely needed to improve the quality of the system from the start and then reduce the cost and time of test. Ways of establishing a more cooperative attitude between the parties is also needed. That plan is based on three simple elements; common sense, trust and cooperation.

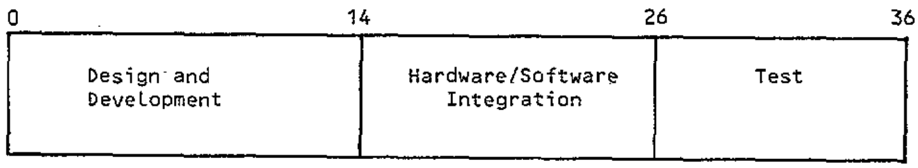

Figure 1 Program Phases

BACKGROUND

The purpose of Acceptance Testing is to verify that the simulator performs in accordance with the original PIDS and SOW and any approved contractual changes. Sometimes test ends up being the first time the user sees what he has ordered. This hands-on look is then compared objectively and subjectively with what he thought he ordered. If the customer is satisfied, the remainder of the program can go well. If not, a lot of questions are asked. There are some simple key elements which, when planned properly, will ensure a satisfied customer and contractor.

The SPEC and SOW

The fundamental requirement of customer testing is a good spec and SOW from the very beginning. All too often these documents have sections which allow a good variety of bizarre interpretations. Vague areas must be uncovered by either the contractor or buyer during the proposal phase or together at the very beginning of the development phase. Otherwise, tangents can be taken until Preliminary or Critical Design Review or even Test. The user must fully know what he wants the system to accomplish. The buyer must then fully understand these requirements, resolve uncertainties and reach a final agreement with the user on these specific capabilities. All spec and SOW paragraphs must be reviewed very early in the program. The Systems Requirements Review (SRR) is the last public review of the spec, SOW and any other documented requirements against the system's intended capabilities. All the requirements should map into contractor designed capabilities of the system. Once accomplished, there is a firm, agreed to and fully coordinated baseline from which to build.

While you can't prevent one party or another from changing their mind, the minds must be as absolutely firm as possible at the baselining of the system's design. Any changes afterwards must immediately go through the same rigorous review to re-establish a complete understanding of the change and new baseline. The sooner any kind of change is a definite candidate for inclusion, the sooner it should be incorporated.

The Test Matrix

As the spec is developed by either the customer or contractor, a Test Matrix needs to be set up and included in the spec. The matrix identifies what method (e.g. Inspection, Analysis, Demonstration and/or Test) will be used to verify the requirements in each and every paragraph. Either during the source selection process or right after the contact award, the customer and/or contractor must break out and determine paragraph by paragraph the best test method for each requirement presented. Once accomplished and agreed to, the contractor has the necessary basis for writing detailed test procedures.

Test Procedures

Writing the test procedures(e.g. Verification Test Procedures used by the contractor and Qualification Test Procedures used by the customer) must be an interactive process between the contractor and the customer. An essential premise is that the spec is fully understood by everyone and, via PDR, CDR and other communication, all parties know what is being tested. The outline should be the test matrix with complete traceability from the test matrix to the test procedures. At the same time, the contractor needs to make sure as the unit specs are written, provisions are made which will allow the system's requirements within a unit's function to be tested in accordance with the PIDS/test matrix. When the contractor finds inconsistencies in the test matrix or better ways of testing the system, the changes must be presented to the customer and resolved as quickly as possible.

An important theme in writing the procedures is "No Surprises". All too often the customer expects to test for certain capabilities one way, only to find out that the procedures are poorly written, fall far short of properly testing the capability or are missing. Test plan working group meetings must be held early so all parties can review the procedures as they are developed. An attitude of "nothing is final" should prevail. If procedures are lacking substance, all parties should cooperatively agree to modify the procedures. Once good test procedures exist a meaningful test can be conducted.

Test Schedule

Each contractor has their own scheme to system testing during development, but they are all basically the same. Initially, the hardware and software are individually tested. Baselined hardware and software configurations are established. Once the hardware and software is integrated and the complete system is up and working the contractor's engineers begin their battery of tests on the system.

During these engineering-run tests there is a detailed debugging of the system and test procedures. This phase of test can run very long. Problems not found or solved during HSI should usually be taken care of here. The procedures used may be identical to the procedures the customer will use or at least as thorough. New tests or steps may have been added from system changes resulting in the course of debug. Since a lot can be missed during procedure development, all the ambiguities and confusion are not removed from the procedures until they are actually run.

Once engineering is satisfied, a more formal test can be conducted with QC witnessing the test, that is if QC didn't watch the first several attempts. If QC did witness the tests previously, then the customer's in-plant representatives would witness the next formal running of all the test procedures. In some cases, he signs-off on all procedures before the customer runs them.

Finally, the customer comes in and runs the tests. Running the tests now formally constitutes the customer's check-out of the system. The system and test procedures should be perfect since they have been run numerous times by different parties. Of course, we all know that things never work the first, second or third time around.

Obviously, a lot of time has been spent in running procedures on a system that let's assume has been working correctly. If not working correctly, the system shouldn't be tested outside of engineering. All parties involved during the test phases do have legitimate claims to witness and/or perform the tests. QC needs to be an independent party, if for no other reason, to double check engineering's work or at least a second set of eyes verifing the engineer's running of test. The in-plant rep needs to verify all the work that the others have done so he can properly notify the customer. By using some advanced planning and rethinking (i.e. common sense), changes can be made to reduce the number of times the system is tested.

THE TEST

The ultimate goals of test are to verify the customer is getting a system that works in accordance with the spec and is shipped from the contractor's facility with no discrepancies. With good test procedures, all the system performance problems should be found and corrected during in-plant test. There should be no further design work on-site unless a problem does not surface until it is there. The problem solution must be known, verified and ready to be installed at the site. This means installed and working like it did in plant not installed to see if it works.

The degree and length of test should be commensurate with the complexity of the system and consistent with the test matrix (i.e. system requirements). The customer should keep the number of tests and length of tests down to a reasonable number but thoroughly test the system. Making the tests more efficient in time to run and intent should be a goal during the test procedure writing and system design phases. Combining several distinct tests under one set-up, where feasible, saves the time of multiple lengthy set-ups. If all the specific capabilities can be independently tested and verified, or faults correctly isolated, the customer should be satisfied.

Coping With Precedents-The Contractor

In order to accomplish the goals stated above, there are several doctrines which have been held sacred that warrant change. On the contractor's side, some believe that every test must be structured with discrete inputs and outputs and subjective tests are forbidden. The intent should be only to minimize the subjectivity in tests not eliminate it. Contractors must write test procedures that objectively measure parameters. Some evaluation tests (e.g. aero or engine performance, radar return presentations, etc.) may have some allowable subjective areas but with an agreed to judgement or measurement criteria established.

The second item is every spec requirement is testable, objectively, subjectively or difficultly. There would be no customer requested tests that are "out-of-scope" during the test period. The customer should be allowed to run tests that are not called out in the test procedures, an embellishment of an existing procedure or something "off-the-wall" that someone wants to look at after the test shift is over on an "as available" basis. If everyone follows the rules, there should be time for those tests. If the test fails, a cooperative effort is needed to evaluate whether or not the capability tested is a spec requirement and should have passed. With a good spec, the resolution should be easy. The customer needs to be allowed to satisfy himself of what he is buying. A contractor's effort to force that satisfaction in the long run doesn't work and is unnecessary.

A third and even more important point is not to test a system if it isn't ready. All too often, when the test date arrives and the test readiness meeting takes place, the system isn't ready and fails miserably or problems occur very early in test and lead to a suspension of testing until the system is really ready. If the contractor has continuously kept the customer informed and been doing good work all along, he should be ready for test as scheduled. If not, admit it. The customer can tell when the system is not working. It's always better to be told the system is not ready than bring in the forces and find out the system isn't ready.

The Customer's Team

Several doctrines need changing by the customer too. The customer must realize that if the system is not ready, it's not ready. Bringing in people to begin test anyway will not intimidate the system into working. The system belongs to everybody until it is accepted and is therefore everybody's problem. Where the customer can help the contractor he should do so regardless of who caused the problems.

During test, the customer is prone to have two or three gaggles attending. All related agencies need to have some visibility in test, but it just doesn't take all those hands and eyes to find the answers. The size of the test teams must be kept reasonable. The number of people performing tests must also be minimized. The customer should coordinate who is responsible for testing and who for monitoring. By reducing the size and defining responsibilities, overall test time and complexity can be reduced.

A long held, erroneous policy is that the hands on the system don't belong to the contractor. The contractor can usually perform tests better than a customer because, lets face it, he has more experience with the system. The customer should be the one doing the customer tests, but contractor assistance at times helps greatly. The customer should consider getting the customer Integrated System Familiarization (ISF) training during the later part of contractor testing as opposed to after installation. The customer learns the system and its operation from the contractor in classroom courses and over-the-shoulder training on the test bed. The customer would be very familiar with system operation and better capable to conduct the test. If not before, there will be time later for the customer to learn the ropes.

A critical issue is for those people who wrote the specs, attended the reviews and developed the test procedures, to be the ones present at test. New or at least uninformed players are not appreciated or productive and often lead to trouble. There is no reason why a system that has been reviewed and coordinated by responsible parties through development should suddenly become non-spec compliant during test. Those carrying authority at test should also be carrying a complete knowledge of the program or rely on a correct source of information.

THE BASICS

Communication and Trust

Across all parties and phases, there has to be communication and trust. Trust evolves from good communication by all parties working together from Day One. The need is evidenced by problems which have resulted from the customer and contractor poorly communicating and coordinating especially on critical issues. This has led to surprises at critical milestones and difficult problems to resolve. At design reviews, the customer must relate any uncertainties or known problems to the contractor. History shows problems surfacing very early at design reviews, never being questioned by either group, contractors having completed major design reviews implicitly or explicitly knowing the customer has accepted the design, and then learning much later, obviously very surprised, the customer feels the design isn't spec-compliant. When a problem arises, the essential people must be informed and address the problem early. Good communication must prevail not only at the design reviews but between them. Infrequent communication leads to surprises, and a break down in coordination and trust.

A common problem that develops very early in the program and must be stopped immediately, is the adversarial relationship. If the contractor is keeping the customer abreast on a continual basis, and vice versa, there should never be any surprises. Each side should have complete visibility, with the problems identified and worked early.

The Team Concept

Actually there should be no sides. The program consists of one team not two. From the very start, the contractor and customer must work the program openly and together. The contractor still bears the burden of the effort, but the customer bears the responsibility of keeping the contractor aware of what he is after in all possible areas. With common sense and cooperation, the engineering, contracts and program management elements within the team can maintain close contact without holding up progress. With common sense and cooperation that is possible. Cooperation and trust are the basis for reductions which will allow the effective changes to take place. Team work is the most important key to the program's success. Team work will also reduce the complexity of the test phase.

THE NEW SCHEME

Obviously, reducing the number of times the system is tested is the key to reducing lengthy test schedules. Team work and a completely open mind towards new ideas are the key to making it all happen. While the final decision and method must be guided by the type of program and the resources available, reduction of in-plant and on-site contractor and customer test phases, on development as well as the production systems, is always possible.

During the contractor test phase, HSI can include unit testing (Fig. 3). With careful study and matching of HSI to unit testing, this type of streamlining can be effective in many cases. Additionally, reducing the verification test time of the system can be accomplished in one of two ways. The first is to have the last complete Verification Test Procedure (VTP), performed by contractor engineering, witnessed by contractor QC (Fig. 4). The second option is to have QC and the customer run the ATP (or VTP) (Fig. 5). Even though some debugging can still take place during these final contractor tests, the customer or rep can see tests sucessfully accomplished and tests with problems corrected and verified.

During customer qualification testing, at least two areas of overlap with contractor testing can be eliminated. The first is in baselining the software configuration (e.g. Coldstart). Currently, the load is coldstarted at the beginning of contractor VTP, beginning of QC test and then at the start of QTP. The customer should know the software configuration at the start of and all through his Qualification Test. Instead, the coldstart at the start of and updates during QC/Rep test would be witnessed by the customer. Prior to the start of QTP, any final updates would just need to be witnessed by the customer as opposed to performing a lengthy complete coldstart. With proper attention given, the configuration of the load should be as secure as a complete re-baselining.

The second combination of efforts is in performing the Inspection and Analysis parts of the QTP. The review of the analysis can be done anytime prior to the start of Qualification Test. The inspections are typically hardware related. The hardware configuration and condition typically does not change between the time contractor engineering and/or QC does their inspections and Qual Test. The customer or rep can witness the contractor's inspections with any changes or corrections inspected prior to the Qual Test. Necessary inspections are still performed and witnessed by the concerned parties, and the integrity is still verified with saved effort.

Time can also be saved by combining the contractor and customer test phases. Qualification tests, in whole or part, at the system level, conducted concurrently by the contractor and customer requires a team attitude. All systems, to varied degrees, lend themselves quite readily to a combined test effort. Low risk areas with high probabilities of success (e.g. Inspections and Analysis) are definite candidates. Areas considered more risky can also be tested once or repeatedly by the team to realize a time savings. The ultimate goal is to see capabilities work properly by legitimate tests and not how many times a test is sucessfully accomplished. By combining two distinct complete test efforts, the time to complete test can be significantly reduced (Fig. 6). Another benefit of the team plan is that by having both the contractor and the customer present, discrepancies can be quickly identified and then explained, corrected and verified. Both team members will gain a better understanding of the system and its capabilities. Each will also share in the other's perspective, which can

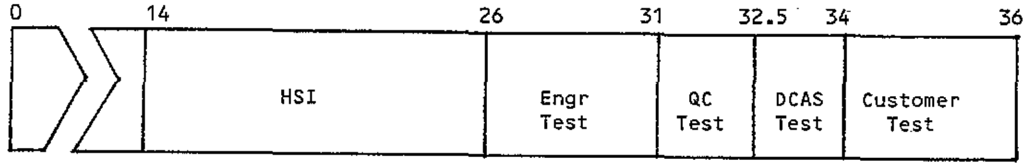

Figure 2 Current Test Schedules

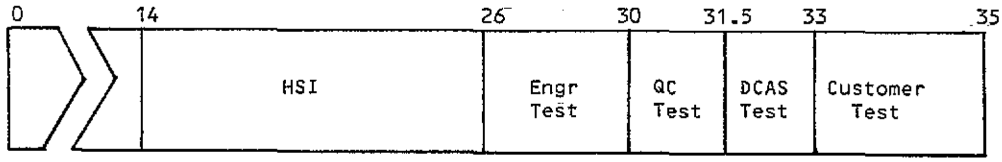

Figure 3 Streamlining--HSI with Unit Test

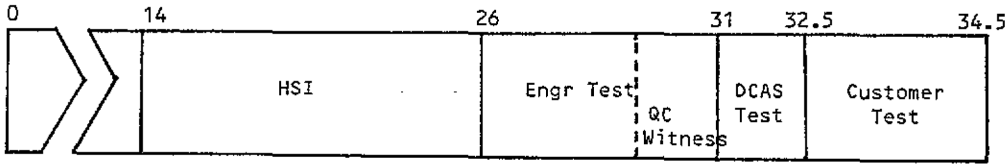

Figure 4 Concurrent Engineering and QC Testing

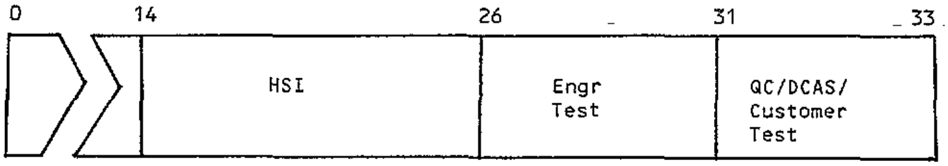

Figure 5 Concurrent QC/DCAS and Customer Testing

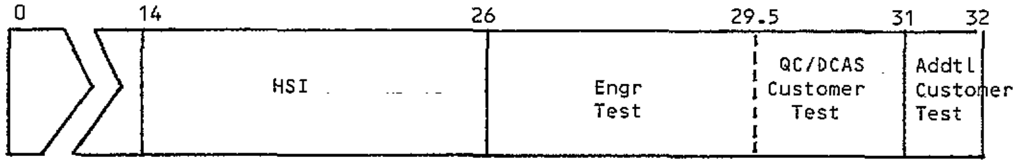

Figure 6 Total Concurrent Testing

otherwise become a barrier to progress. A better understanding will also benefit the customer in later verification of the discrepant area.

The team can use the results of this dual in-plant testing to streamline on-site acceptance testing down from a complete QTP run through. The customer's improved insight into the system will give him a better base on which to build the on-site test schedule for the development or production units. He will be more able to pick those areas or tests that need attention and testing. He can also perform testing with the contractor engineers and/or QC. The contractor can streamline early in the installation, having his QC people actively involved with the engineers in the buildup and verification of the hardware. Further, the QC inspection/tests can be incorporated in the engineering test of the system. By any scheme, the overall test effort will be reduced and allow for a dual acceptance of the system.

For production units, the customer may want to waive in-plant acceptances of the units or at least rely on the representative's witnessing the contractor's tests. This approach is best applied when the units are identical or nearly identical to previously accepted development systems. On-site, the philosophy used on the development system can apply. An abbreviated ATP can be performed with QC, or the customer can witness a complete test by engineering and QC. In any case, the test effort is reduced greatly.

THE SAVINGS

When figuring the actual savings a program can realize, the length of the overall program, length of the test phase(s), manpower and associated costs allocated to test must be considered. Taking a typical full mission simulator into consideration, the in-plant and on-site test phases are usually made up of the engineering, QC and customer tests. In-plant engineering tests lasts approximately five months. QC (or DCAS) and customer tests run one and one-half and two months, respectively. On-site engineering, QC and customer tests can run about four weeks each. Looking at the best case on in-plant tests, by doing the QC, DCAS and customer tests concurrently with the last engineering run of the VTP, up to five months can be saved. Realistically, the time would be closer to four months if the customer wants to re-run some of the tests personally or do further tests. In the worst case, where QC and DCAS would do their tests concurrently after engineering followed by the customer, the savings would be one and one-half months. Manpower during the latter parts of engineering test thru customer test can be an average of 10 people working full-time. This includes the key hardware, software and systems engineers, configuration management and test personnel and the associated support people in manufacturing, drafting and program management areas. An average cost for this manpower can be $8000 per man-month. The numbers equate to a potential savings of $120,000 to $400,000. Considering the cost of the entire development program the dollars are insignificant but saving even two months from a ten month test schedule has more tangible benefit, especially to the user.

On-site the benefits possible are an additional six to eight weeks savings if all parties participate in one test. The on-site test group can be made up of five or more people just to support the contractor's testing. On-site in addition to the personnel salary costs there are the living expense costs to consider. These vary greatly area to area and are not small. Even so, the dollars saved are overshadowed by the time saved. In either area there are benefits to the contractor, buyer and user all trying to achieve concurrency and get pilots into simulator training sooner.

CASE STUDIES

F-16 Digital Radar Landmass Simulation (DRLMS) System

Elements of the new way of doing business have already been tried. What happens when certian elements are not done has also been reviewed. The first case to cite is the F-16 Digitial Radar Landmass Simulation (DRLMS) System development contract with the General Electric Company's Simulation and Control System's Department in Daytona Beach, Florida.

Within the first six weeks of the program, which began in August, 1981, a Post Award Conference(PAC) was held to review the PIDS, SOW and other contractual requirements documents. Even though program team's key members, on both sides, remained almost the same as the final source selection reviews, a number of issues arose indicating not everyone was in sync with the requirements and capabilities. While these issues were resolved at the PAC and subsequesnt design reviews and requirement re-reviews, a much better review at the PAC would have eliminated the continuing resolution of spec issues. The team was relieved the PAC was conducted in the beginning or serious problems could have resulted.

Communication of the team members was always very good. The atmosphere at and between the design reviews was very open. A great deal of work was accomplished at these meetings as evidenced by the volume of substantive briefing charts prepared and resulting minutes. Major issues which could affect the evolving design were resolved at the meetings to everyones satisfaction. Unless radically new information was presented later, the decisions made were not changed at the next meeting. When problems were uncovered, they were made known and resolved early so the program would keep moving. Actual surprises were kept to a minimum and the trust among all the players was very good. While GE and USAF were defensive of their positions, no one was unwilling to yield something to reach a satisfactory solution.

There was excellent program team continuity throughout system development and into qualification testing. New program people learned the past history of the system quickly and while they may not have agreed with all the decisions made before hand, they respected the team's stand and did not try to undo progress made.

Recognizing past problems, an extensive effort was put into the development of the Qualification Test Procedures. A complete test matrix was in the PIDS at contract award. GE wrote the test outline based on the matrix. The outline was reviewed and approved at the first Test Plan Working Group meeting as well as the general format to the procedures and their content. After the detailed procedures were written by GE, sent to the team members and comments generated a five day second meeting was held to thoroughly review each test procedure. All aspects of the tests from clarity of the steps to applicability of the steps to testing the requirement were discussed. While substantial portions of the QTP were modified, everyone involved was satisfied with the quality and usefulness of the QTP. Six weeks prior to the start of test, the final meeting was held to review all the changes which had been incorporated from the second meeting. Also included were proposed changes from GE engineering based on actual test experience during Verification Test. Once again substantive comments were generated, discussed and incorporated into what became the final QTP prior to test. Even after test began, very minor corrections were made to the procedures. As a result of all the efforts, very few problems occured during test due to procedure errors and none due to the lack of a test's applicability to the requirement.

The start of test did not go according to schedule. Due to a problem in coldstart procedure and data file development just prior to the start of coldstart, the effort done by the user ran into problems. The USAF and GE worked closely together to correct the problems encountered during coldstart and were able to finish the first run. Both sides agreed, that while not in the schedule a second run should be made to totally verify the software load integrity. Actual system test also did not begin until all the system's descripancies were resolved to everyone's satisfaction. To save some time, several of the procedures not yet run by DCAS were done by USAF and DCAS together. Prior to the start of Qual Test, there were a few lengthy procedures run by GE QC and DCAS together. Even though running the qualification test procedures began late, it did not have to be suspended because the system was not ready. A planned three week test was completed in three weeks with a minimum of descrepancies logged and weeks ahead of the original schedule.

The user personnel actively participating in test had either been on the program long enough to know what the system requirement/capabilites were and/or had just finished eight weeks of ISF training on the system. The ability of these people to conduct test was very high. The contractor was always around to help where needed and at times preformed the tests with the USAF group watching. All through test the communication, trust and atmosphere was very good. Discussion of problems and solutions arising during test were openly discussed. Only one problem ended up becoming a long time hold over from the design phase. Fortunately, the trust of the team members enabled the matter to be finally resolved with total team satisfaction. GE had to prepare some analyses not originally planning and USAF had to agree that the spec wording was not as clear as it could have been. GE worked with the USAF to show that the system design would be adequate enough to satisfy the user's ultimate need. Through cooperation, the time to resolve test issues was significantly reduced compared to other system tests. At the end of DRLMS test, the system was working in accordance with the PIDS and problems noted in test had the fixes installed or verified on a second in-plant unit and ready to install in the field.

The F-16 DRLMS program was not a perfect program, but with some new attitudes present during the program, it was a very sucessful program. Through everyone's hard work no one came out a loser.

F-15 Operational Flight Trainer (OFT)

A second case to cite is the F-15 Operational Flight Trainer (OFT) program which is under a production contract with Goodyear Aerospace Corporation (GAC) in Akron, Ohio. The F-15 OFT program is another example of how the new way of doing business saved time and schedule costs and ensured that the trainer was delivered to the user on time.

The F-15 OFT had a major technical facelift when a major ECP was put on contract in 1983. In the effort the computational system was replaced by the Gould 32/8780 computer, the system software was converted to Fortran, and the displays were replaced at the instructor operator station. The effect of this change was major to all parts of the simulation. Therefore, early in the program the test time was scheduled to reflect a major effort. The test was scheduled for 840 test bed hours predicated on a 12 hour a day, five day a week schedule. From the beginning of the effort the specification was well defined. The players on both sides, through extensive participation in the design process, had a good understanding of what the end product would be. At the preliminary design review (PDR) and critical design review (CDR) the basic concepts were worked out mutually by GAC and the AF. GAC welcomed the user's comments and suggestions on how to improve the simulator's capabilities and make it an easily usable system. The interchange carried through the entire program leading to a quality device with as many user changes incorporated as feasible. The continuity on the program helped to ensure that all team members had equal expectations at the start of acceptance testing. Although each of the test team members represented their own organizations interests, the conflicts were worked out to the best abilities of all involved and the end result was a quality product from the "big picture" view.

The acceptance test procedures (ATP) were basically the same procedures which had been developed and used to test the first ten F-15 OFTs. The quality of the ATPs was very good and required the technical changes to reflect the new computers, software and system operating software. However, in any major update such as this (approximately 12 volumes at 300 pages per volume) it is very difficult to pick up all the small detailed changes. The expertise of the test team members was invaluable in identifying oversights to the contractor and enabling the test to continue. By having a good working knowledge of the system prior to test, the test team was able to continue testing without having to wait for ATP correction updates. This saved hours of test time for both the contractor and the test team.

The beginning of test started as scheduled with a formal Physical Configuration Audit (PCA) followed by a general inspection of the system hardware. This effort resulted in many unexpected discrepancies, most of them minor, but some which pointed out a definite deficiency. The contractor quickly picked up the ball and corrected those discrepancies on his system. The benefit of this effort came in the identification to the prime contractor of specific deficiencies in the equipment supplied to him, by his subcontractors. This lead to a few visits to the subcontractor's facility and discussions which outlined in more detail the standards to which the subcontractors must perform. The end result was the ensured quality product upon which GAC had built its reputation.

Incorporated into the update to the computational system was an overhaul of the aerodynamic and engine simulations. More accurate data obtained through years of test and utilization of the F-15 aircraft was available from the Air Force and incorporated into the software simulation. The data was not delivered to allow the whole simulation to be incorporated prior to test. The contractor presented a two phase effort to the team which allowed all but approximately ten percent of the simulation to be ready to test. This approach was agreed to by the team. However, the incorporation of this software was not available at the beginning of the acceptance test. The test team instituted work arounds to the schedule. Meetings were held with the contractor's functional engineers to determine the impact that the new software would have on test and based on the findings and the contractor's recommendations the schedule was reworked and testing continued. The team work displayed saved a four week slip to the test schedule.

A one week pilot evaluation was scheduled to begin following completion of the acceptance testing. As the time drew nearer significant problems were encountered in the Head Up Display (HUD) and radar simulation. This area was very crucial to a successful and effective pilot evaluation. The contractor's functional engineers jointly tested with the AF test team. The problems were more quickly identified and fixes incorporated. This enabled an effective pilot evaluation, however, the entire ATP was not completed as scheduled. To save the time of rescheduling the pilot evaluation, the team extended the test time by four hours per day and deferred testing of non-aircraft simulation testing, such as cycle time verifications and some computer diagnostics testing, until second shift during pilot evaluation. This saved a potential of a three week slip to the schedule.

Another time saving measure employed during test was the use of the contractor's software development center to perform the necessary disc updates during the test. Backup disc packs were updated by an Air Force test team member with the assistance of a contractor engineer on a similar system to the computational system on the OFT. This allowed the testing to continue on the trainer with the previous revision disc pack. A verification of the update was also performed to ensure that all expected changes to the software had occured. Following the disc update, the new revision disc pack was placed on the trainer and a quick checkout performed to ensure that the software could "fly" on the OFT. During the test twelve disc updates were performed on the alternate system which saved the same number of test days to the schedule.

Although everyone's original expectations and definitions of acceptance testing were not met, the teamwork that was demonstrated as the test progressed led to a thorough evaluation of the trainer against the requirements. The end result was not only a quality device, but a better understanding on all sides of each other's needs and techniques which could be applied to the next test.

CONCLUSION

Teamwork is not the solution to all the problems faced in the development of new high tech systems. Teamwork is though an important and viable means to reducing the problems which have long plagued system development. Those problems have been people not technology oriented. With better communication between all parties from the beginning a much better working relationships can be formed that will greatly enhance the efficiency of the system design, development and problem resolution. Carrying the cooperation and trust over into test can allow for a combination rather than segregation of test efforts. While the dollars saved may not be a significant incentive to prompt such planning, the time saved is very beneficial. Elements of the philosophies presented in this paper have already been sucessfully applied. The ideas presented are not revolutionary. Most program managements though have not taken steps to any great extent to promote these ideas. The steps to carry out the whole idea are small. What is ultimately needed is a realistic look at this philosophy and apply the ideas in the beginning and not at the end of a program. Once those incharge become less parochial and allow new concepts to be implemented, new or even existing programs can be carried off more effectively.

ACKNOWLEDGEMENTS

This paper could not have been put together without teamwork. The authors would like to thank Messrs. Gary Nye and Domenick Zirpolo, GE/SCSD, Daytona Beach, Florida, Lt. John Stizza, Simulator System Program Office, Wright-Patterson AFB and Mr. Robert Manning, Singer-Link Flight Simulation Division, Houston, Texas, for their insight and meaningful comments on the content of this paper. Appreciation also goes to those who inspired this paper by saying the ideas presented will never work.

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